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Effect of Calcium Hydroxide Intracanal Dressing on the Bond Strength of a Resin-Based Endodontic Sealer

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The aim of this *in vitro* study was to evaluate the bond strength of Epiphany™ resin-based sealer to dentin walls after placement of calcium hydroxide [$Ca(OH)_2$] dressings. Fifteen extracted single-rooted human teeth were instrumented using 2.5% NaOCl + EDTA as irrigants. The teeth were randomly assigned to 3 groups (n=5), according to the intracanal dressing: G1= $Ca(OH)_2$ + saline; G2= $Ca(OH)_2$ + 2% chlorhexidine gluconate (CHX) gel; and G3= saline (control). After 10 days of storage in 100% humidity at 37°C, the dressings were removed and the root canals were filled with Epiphany™ sealer. After additional 48 h of storage, the specimens were sectioned transversally into 2-mm-thick discs. Push-out tests were performed (1 mm/min, Instron 4411) and the maximum loads at failure were recorded in MPa. One-way ANOVA and Newman-Keuls tests showed a statistically significant decrease in bond strength when a $Ca(OH)_2$ dressing was used before root canal filling with Epiphany™ (G1= 10.18 ± 1.99 and G2= 9.98 ± 2.97) compared to the control group (13.82 ± 3.9) ($p < 0.05$). It may be concluded that the use of $Ca(OH)_2$ as an intracanal dressing material affected the adhesion of Epiphany™ to the root canal walls, but even though the values were within the acceptable range found in the literature.

Key Words: adhesion, bond strength, calcium hydroxide, root canal sealers.

INTRODUCTION

An efficient coronal sealing of the root canals walls, after instrumentation is one of the goals of the endodontic filling phase. Although root canal instrumentation procedures have been improved considerably over the years, no current technique is able to provide a complete cleaning of the root canal system, especially in narrow, curved or flattened roots (1).

Even after meticulous biomechanical preparation, bacteria may survive, grow and multiply, having an important role on the outcomes of the endodontic treatment (2). The use of an effective intracanal dressing has been suggested by several studies as an important procedure for bacterial reduction (2,3). Calcium hydroxide [$Ca(OH)_2$] is the most widely used and investigated intracanal dressing material in endodontics because of its antibacterial and biological properties (2).

Chlorhexidine gluconate (CHX) has also been suggested as an effective irrigating solution and intracanal medication (4,5). CHX has the capacity to adsorb to dental tissues and mucous membrane with a prolonged and gradual release at therapeutic levels known as substantivity (4). CHX has been proved effective against microorganisms commonly isolated from refractory endodontic infections resistant to conventional therapy with $Ca(OH)_2$ (6). Current studies have shown that the association between $Ca(OH)_2$ and CHX is effective,

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reaching good results after root canal treatment performed in animals with induced apical periodontitis (4,5).

The influence of irrigating solutions and intracanal medications on bond strength (7) and adhesion (8,9) of endodontic sealers to dentin has been subject of several studies. It seems to have a special importance since new concepts and techniques of adhesive root canal filling materials have been recently introduced (10).

The association between Resilon and Epiphany™ sealer (Pentron, Wallingford, CT, USA) has been tested and proved more effective in decreasing gaps between the filling material and the root canal walls (10), minimizing the coronal microleakage (11). Epiphany™ is a dual-cure resin-based sealer, which has been advocated to be able to bond both the core material (Resilon, Pentron) and the adhesive system that penetrates into the dentin tubules (10). The aim of this *in vitro* study was to evaluate evaluate the effect of different $Ca(OH)_2$ dressings on the bond strength of Epiphany™ resin-based sealer to dentin walls.

MATERIAL AND METHODS

This study was approved by the Research Ethics Committee of the University of Passo Fundo, RS, Brazil (Process #246/2006).

Fifteen extracted single-rooted human teeth had the crowns removed at the cementoenamel junction level using a water-cooled diamond disk mounted in a low-speed handpiece and the pulp tissue removed using a K-file (Dentsply/Maillefer, Ballaigues, Switzerland) under irrigation with 2.5% sodium hypochlorite (NaOCl). The working length (WL) was determined by introducing a size 15 K-file into the canal until it reached the apical foramen and withdrawing 1 mm from this length.

The teeth were prepared with RACE rotary Ni-Ti files (FKG, Lachaux-de-Fonds, Switzerland) up to a size 40 .02 taper file at the WL and irrigated with 2 mL 2.5% NaOCl between instruments. The coronal and middle root canal thirds were enlarged with a cylindrical 1.50 mm post drill (FibreKor Post System, Pentron), followed by a final flush with 3 mL 17% EDTA (Pulpdent Corporation, Watertown, MA, USA) for 1 min.

All canals were dried with absorbent paper points and the teeth were randomly assigned to 3 groups (n = 5), according to the intracanal dressing: G1= $Ca(OH)_2$ + saline; G2= $Ca(OH)_2$ + 2% CHX gel; and G3= saline (control).

In G1, the intracanal paste was prepared by mixing $Ca(OH)_2$ powder (Quimis Mallinkrodt, Inc., Philisburg, NJ, USA) and saline (Abbott, Chicago, Il, USA). $Ca(OH)_2$ powder was added to saline until reaching a consistence similar to that of toothpaste, as proposed by Gomes et al (13). In G2, $Ca(OH)_2$ powder was added to the 2% CHX gel (Endogel, Itapetininga, SP, Brazil) until reaching a creamy consistence in order to facilitate its placement into the root canal with a lentulo spiral.

The coronal openings were sealed with a cotton pellet and a temporary filling material (Cavit; ESPE America, Norristown, PA, USA). After 10 days of storage in 100% humidity at 37°C, the intracanal dressings were removed using a size 40 taper.02 Ni-Ti file at the WL and 3 mL of saline as irrigant. All specimens were dried with abosorbent paper points and coated with a self-etching primer (Epiphany Primer, Pentron) applied with soaked paper points. Thereafter, the canals filled with Epiphany™ using a lentulo spiral. The excess material was removed with moist gauze and the sealer was light-cured for 40 s with the tip of the light guide placed at the coronal access. After 48 h of additional storage, all specimens were sectioned transversally into 2-mm-thick discs in a precision sectioning machine using a water-cooled diamond saw (Isomet, Buehler, Lake Bluff, IL, USA). Push-out tests were performed at a cross-head speed of 1 mm/min in a universal testing machine (Instron 4411; Instron Ltd., High Wycombe, England). In order to express the bond strength in MPa, the load at failure recorded in N was separated by the area of the bonded interface, which was calculated using the following equation: $A= 2 \pi r \times h$, where π is the constant 3.14, r is the root canal space radius, and h is the thickness of the slice in mm.

The data were recorded and submitted to statistical analysis by one-way ANOVA and Newman-Keuls test using BioEstat 2.0 program (CNPq, 2000, Brasília, DF, Brazil).

RESULTS

The statistical analysis showed that the G1 (10.18 ± 1.9 MPa) and G2 (9.98 ± 2.9 MPa) were statistically similar to each other ($p>0.05$) and that both experimental groups presented significantly lower bond strength than that of the control group (13.82 ± 3.9 MPa) ($p<0.01$).

DISCUSSION

The use of intracanal medication has been advocated to improve the root canal disinfection (4). Temporary root canal dressings are intended to act against bacteria that were not eliminated after conventional endodontic biomechanical preparation.

$Ca(OH)_2$ and CHX have confirmed antibacterial properties and can be used either alone (2) or combined (4,5), in order to reach a successful endodontic treatment outcomes. $Ca(OH)_2$-containing materials have been used in endodontic therapy also to stimulate hard tissue formation and to mediate the neutralization of lipopolysaccharides (4). However, it cannot be considered as a universal intracanal medication because it is not effective against some resistant microorganisms (6). Therefore, the association of $Ca(OH)_2$ and CHX aims to enhance the antimicrobial efficacy, particularly against *Enterococcus faecalis* (4).

The intracanal dressings must be removed from the root canals prior to the final obturation in order to obtain the best interface possible between the canal walls and the filling material. However, it has been demonstrated that $Ca(OH)_2$ pastes are not easily removed from the root canal system (12), which might explain the results of the present study. In the groups in which $Ca(OH)_2$ was used, the bond strength values were lower than that of the control group, suggesting that the residues of $Ca(OH)_2$ paste left into the root canal space could have interfered with adhesion of Epiphany™ to the root dentin.

On the other hand, CHX when used alone as a liquid endodontic irrigant before root canal filling has beed shown to increase sealer bond strength to dentin (13). In the present study, $Ca(OH)_2$ and a 2% CHX gel were mixed until obtaining a toothpaste consistence. Therefore, the difficulties in removing this material from the root canals seem to be the same as that encountered with any $Ca(OH)_2$ paste (12).

Although the use of $Ca(OH)_2$-based pastes decreased the bond strength of Epiphany™ sealer to root dentin, the values remained relatively high in all groups when compared to the data reported in the literature, suggesting that even with the interference of $Ca(OH)_2$, the adhesion of Epiphany™ to dentin is acceptable.

Another important issue is that ISO, the international organization for standardization, does not provide the minimal required bond strength values for endodontic sealers. Different mechanical methods of evaluation have been proposed, such as shear bond strength (14,15), microtensile bond strength (7) and push-out tests (9,13,16), and different values of bond strength have been reported, even for the same material. The push-out test was used in this study for being easy to reproduce, to interpret and also for being able to realistically record, at even low levels, the bond strength to dentin (17,18). The hypothesis that push-out tests are operator-dependent (19) was not considered, since the bonding procedures were made by the same operator.

In the light of this study's findings, further research should be carried out, seeking for the best technique for $Ca(OH)_2$ removal from the root canals, or to investigate the assumption that the bond strength achieved with the present method is clinically able to increase the chances of success. It may be concluded that the use of $Ca(OH)_2$ as an intracanal dressing material affected the adhesion of Epiphany™ to the root canal walls, but even though the values were within the acceptable range found in the literature.

RESUMO

O objetivo desse estudo *in vitro* foi avaliar a resistência de união do cimento resinoso Epiphany™ às paredes dentinárias após aplicação de pastas de hidróxido de cálcio [$Ca(OH)_2$]. Quinze dentes humanos uniradiculares foram igualmente instrumentados sob irrigação com as soluções de NaOCl 2,5% + EDTA. Os dentes foram divididos em três grupos (n=5) e tratados com diferentes pastas de $Ca(OH)_2$: G1= $Ca(OH)_2$ + soro fisiológico; G2= $Ca(OH)_2$ + 2% CHX e G3= tratado apenas com soro fisiológico (grupo controle). Após 10 dias de armazenamento a 37ºC e 100% de umidade, as medicações foram removidas e os dentes obturados com o cimento Epiphany. Passadas 48 horas de armazenamento adicional, as amostras foram seccionadas tranversalmente em discos de 2 mm de espessura. Os testes de resistência de união (*push-out*) foram realizados em máquina de ensaio mecânico (1 mm/min) e os resultados expressos em MPa. Os testes de ANOVA e Newman-Keuls mostraram um significante decréscimo nos valores de resistência de união quando as pastas de $Ca(OH)_2$ foram utilizadas (10,18 ± 1,99 e 9,98 ± 2,97) em comparação ao grupo controle (13,82 ± 3,9) ($p<0,05$). Pode-se concluir que o uso do $Ca(OH)_2$ como medicação intracanal diminuiu a adesão do cimento Epiphany™ às paredes dos canais radiculares, embora os valores de resistência de união estejam dentro das médias aceitáveis encontradas na literatura.

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